



1985 Missouri Commercial Strawberry Spray Schedule

A. E. Gaus, Horticulture
E. W. Palm, Plant Pathology
W. S. Craig, Entomology

J. F. Moore, Plant Pathology
H. Townsend, Entomology

University of Missouri-Columbia
Extension Division
MP 266 1/85 1.5M

State Fruit Experimental Station
of Southwest Missouri
State University

These recommendations are intended to serve as guidelines for commercial strawberry growers in Missouri. The pesticides and application rates listed for any given pest problem are based on their effectiveness, economy, safety and general integration into control programs for other pests present at or about the same time. The choice of which chemicals to use, when to use them, and how they are applied must be made by the individual grower relative to his own experience, equipment, and special problems associated with his fields. The effective and efficient use of all pesticides requires careful selection of the most appropriate material and the rate required, critical timing of the application(s), and uniform, thorough coverage of the plants.

PESTICIDE SAFETY

Responsible use of pesticides also includes their safe storage and handling. Most pesticides are poisonous to people and animals. Handle them with care. Store them only in their original, labeled containers in a dry, locked location out of the reach of children and animals.

READ THE LABEL! Understand it. Know the toxicity of the material you are using and wear the appropriate protective clothing. The greatest hazard with most pesticides occurs during the loading operation before the spray is applied. With highly toxic wettable powder (WP) formulations, empty containers carefully into the tank to avoid undue exposure to the dust; with liquid formulations, avoid splashing and spillage while measuring or making additions to the spray tank.

Avoid contaminating lakes, streams or ponds with any pesticide. Do not clean sprayers or dump excess spray mixtures near any such water supply. Avoid contaminating any crop used for forage or feed by drift of sprays out of the treated fields.

RECOMMENDED RATES OF APPLICATION

All of the rates for the materials in these recommendations are given on an *amount per acre* basis and should be applied in sufficient volume of water to allow thorough penetration of the dense mat of foliage, crowns, runners and mulch present in most beds. A volume of 150 to 250 gallons per acre delivered at a pressure of at least 200 pounds per square inch is suggested. Be sure to spray the *entire planting*—rows and middles.

PESTICIDE CERTIFICATION FOR GROWERS

Missouri's pesticide law went into effect October 21, 1976. This law requires certification for commercial and private applicators to purchase and apply restricted-use pesticides as defined by the Environmental Protection Agency. Since several pesticides used routinely by fruit growers are potential restricted use materials, it is highly desirable that each grower become certified.

Commercial applicators (all applicators who apply pesticides for hire) must pass an examination administered by the Missouri State Department of Agriculture. Private applicators are required to attend a training program, but are not required to pass an examination. Training sessions are offered to both commercial and private applicators by the University of Missouri Cooperative Extension Service. Contact your local Extension Specialist for further information.

| Timing & Major Pests Involved | Materials To Use | Rate Per Acre | Comments and Special Precautions |
|--|---|---|---|
| PRE-PLANTING SOIL TREATMENT | | | |
| Wireworms White Grubs Carrot Beetles | No insecticides are registered. | | Soil insects are most prevalent in sod situations. To avoid excessive damage from soil insects: 1) Plant on previously cultivated soils; 2) Disc and/or plow sod land to be planted several times year before planting; 3) Consider soil fumigation. |
| PRE-BLOOM SPRAYS | | | |
| Cattfacing insects Weevils Rootworms Crown borers | ENDOSULFAN (Thiodan 50W) + GUTHION 50W or MALATHION 25W | 2 lbs. 1 lb. 4 lbs. | Pre-bloom insecticides are primarily for cattfacing insects. Begin applications as soon as growth starts in the spring. Continue every 7 to 10 days to early bloom but do not repeat ENDOSULFAN spray within 15 days or more than twice in 35 day period when fruit is present. During "wet" spring seasons, a fungicide should be applied with the insecticides. |
| Leaf spot Gray mold | BENOMYL 50W + CAPTAN 50W or CAPTAN 50W or THIRAM 65W | 1 lb. 4 lbs. 5 lbs. 5 lbs. | During wet spring seasons, a fungicide should be applied with the insecticides. If fruit rots are likely to be a problem, use the BENOMYL + CAPTAN spray and begin applications when blossom buds begin to separate. See special note on gray mold (back page). NOTE: If you have an anthracnose problem, see special instructions under diseases (back page). |
| BLOOM SPRAYS | | | |
| Fruit rots Leaf spot Leaf blight Leaf Scorch | BENOMYL 50W + CAPTAN 50W or CAPTAN 50W or THIRAM 65W | 1 lb. 4 lbs. 5 lbs. 5 lbs. | If fruit rots are likely to be a problem or if the season is especially wet, BENOMYL + CAPTAN is the preferred spray. NOTE: Reduce BENOMYL rate to 1/2 lb. per acre after full bloom. |
| SPECIAL PRE-HARVEST SPRAY | | | |
| Leafrollers Spider mites | NALED 8EC or KELTHANE 4F | 1 pt. 1 qt. | Apply NALED only if needed. NALED (Dibrom) is highly corrosive. Wash out spray equipment thoroughly after use to avoid problems. NALED may be used to within one day of harvest; KELTHANE to within two days of harvest. |
| HARVEST SPRAYS | | | |
| Fruit rots Leaf spot Leaf blight Leaf scorch | BENOMYL 50W + CAPTAN 50W or CAPTAN 50W | 1/2 lb. 4 lbs. 5 lbs. | Note the reduced rate of BENOMYL during harvest. |
| POST-HARVEST SPRAYS | | | |
| Leafrollers Spider Mites | GUTHION 50W or DIAZINON 50W KELTHANE 4F | 1 lb. 1 lb. 1 qt. | Check your plantings at least once a week. These sprays are recommended only on a "spray as needed" basis rather than a regular schedule. |
| Leaf Diseases | CAPTAN 50W or THIRAM 65W | 5 lbs. 5 lbs. | During wet seasons regular fungicide treatments may be needed to check foliar diseases. Repeat every seven to 10 days until conditions improve. |

TROUBLESOME STRAWBERRY DISEASES

A number of destructive diseases of strawberries cannot be controlled with conventional foliar pesticide sprays. They need to be considered before planting. In each case the importance of using only disease-free planting stock cannot be over emphasized. Plants should be purchased only from reputable nurseries.

Two classes of plants, REGISTERED and CERTIFIED, need to be considered. Plants bearing a "registered" label have been grown under state supervision from tested stocks that are free of certain disease causing viruses or virus-like organisms. This is usually the best stock on which to base your investment. "Certified" plants are also grown under state supervision, inspected and found to be free of most diseases and insects; however, they may still carry virus.

Black root rot is a common disease caused by a complex of soil-borne pathogens. Certain environmental stresses such as drought, excess water, winter injury, and nutrient deficiencies contribute to the severity of this disease. Affected plants are low in vigor, have smaller than normal root systems. Many roots of affected plants show dark, blackish lesions or they may be dead. Control is best achieved by using only disease-free planting stocks and cultural practices that promote strong vigorous growth and lessen winter injury (fertilization, minimal cultivation and mulching). At planting, plants should be inspected and only those with healthy, light-colored feeder roots used. Cut through the crowns of several sample plants and check for internal discoloration. Care should also be given to avoid drying of the roots during planting.

Verticillium wilt is caused by a soil-borne fungus that is most active during cool weather. The disease tends to be more serious in heavy poorly drained soils. Symptoms in new plantings usually appear at about the time runners begin to develop; in established beds they develop near the fruit ripening stage. Outer leaves are usually the first to wilt although sometimes the whole plant may appear wilted. The leaves dry up, turn brown at the margins, and few new leaves develop. New roots growing from the crown are short with blackened tips. Severely affected plants die while less severely affected plants are unproductive, develop few runners, and are predisposed to winter-kill.

The Verticillium fungus is particularly troublesome to control because it can persist in the soil for long periods and has a wide host range including many common weeds and crop plants. Unless the planting beds have been fumigated, strawberries should not be planted within two years after strawberries, tomatoes, potatoes, peppers, eggplants, peaches, cherries, plums, cane fruits or cotton. Fumigation can be costly and often requires special equipment. For this reason the use of wilt resistant varieties such as Guardian, Surecrop, Redchief or Sunrise is the most economical approach where Verticillium has become a problem.

Red stele is a destructive root rot disease also caused by a soil-inhabiting fungus. Infected plants are found most often in low, wet areas. Infection occurs in the late fall and early spring when soil temperatures are cool and soil moisture levels are high. Some infected plants wilt suddenly and die just before or during the first fruiting period. The center or stele of this plant is characteristically reddish brown instead of the normal yellowish white color of healthy roots. In some plants this discoloration symptom may disappear in the summer as the plants appear to recover. However, these plants are usually stunted, produce worthless fruit and generally die the following season.

The red stele fungus is most commonly introduced into new plantings on diseased stock. Within the planting it is spread by water that moves in or over the soil and by soil carried on farm equipment. Once the fungus is introduced into a planting, the only practical alternative to locating a new site is to use red stele resistant cultivars such as Guardian, Surecrop, or Redchief.

Root knot and **lesion nematodes** are microscopic, threadlike parasitic worms that live in the soil and attack strawberry roots. Severe infections occur only when nematode populations are high and this happens more frequently in sandy soils than in the heavier clay soils. **Root knot nematodes** form swellings or galls 1/8 to 1/4 inch in diameter on roots. Usually there are several short branch roots just above the swelling. These galls interfere with normal root functions and, with severe infections, the effect is similar to removing most of the roots. **Lesion nematodes** feed mainly on the fibrous roots and with severe infections these roots appear wiry and brown. Both types of damage cause plants to be stunted, less vigorous, and more susceptible to black root rot, drought injury and winter kill. Certified disease-free plants should always be used to avoid introducing these nematodes into new sites. Like many of the soil fungi these nematodes can also be spread within an area in soil on farm implements.

Anthrachnose. Many Missouri growers experienced a new strawberry problem in 1982 and 1983. Fields planted with plants from Arkansas showed varying degrees of wilting and dying of mother plants, daughter plants and girdled runner stems. The problem was diagnosed as anthracnose. This disease is usually limited to southern growing areas of the U.S., but for some reason—probably unusual climatic conditions—the disease became quite prevalent in Arkansas plants. Other symptoms include a rusty red internal discoloration of the crowns and a sunken, discolored rot on the fruit.

The best method of preventing anthracnose is to start with *disease free planting stock*. Purchase plants from reputable nurseries in states where anthracnose normally does not occur. These states are those north of Arkansas, Tennessee and Virginia in the eastern U.S. Do not take plants from fields infected with anthracnose for new plantings. Sites for new plantings should be isolated (at least 1,500 feet) from an anthracnose infected planting.

Sanitation is important in preventing spread of anthracnose from infected plantings to those free of the disease. Cultivation, spraying, etc., should be done first in fields free of disease. After using equipment and implements in infected fields, clean thoroughly after use with a high pressure waterhose and allow equipment to dry for several hours.

Plantings infected with anthracnose should be plowed under after harvest when they are no longer profitable. The pathogen cannot survive longer than three months in the soil after plowing.

Anthrachnose can be controlled, but not eliminated, with a rigorous program of fungicide sprays. Probably the best that can be hoped for is to slow the spread of the disease and extend the life of the planting. New plantings close to infected plantings should be protected with fungicide sprays. Spray infected and new plantings with 6 lbs. CAPTAN 50W per acre starting at time of flower bud emergence and continue at weekly intervals until late summer (when average daily temperature drops below 75 degrees F). Intervals can be extended to 10 to 14 days if dry weather permits.

GRAY MOLD FRUIT ROT

Gray mold rot occurs wherever strawberries are grown and, in some years, can destroy the entire crop. It is caused by a fungus that can infect the berries at all stages of their development. Infection often starts on blossoms where there are frost or other injuries to the flowerstalks, caps, or petals, or where dead petals cling to developing fruit. Infection may also occur where berries are in contact with decaying plant debris, the soil, or another infected berry.

Initially gray mold fruit rot appears as a brown, soft rot which then spreads rapidly through the berry. As the berry dries out it becomes firm, uniformly brown, and is covered by a gray to grayish brown dusty-looking growth. The disease can be especially destructive in wet seasons or when frequent showers occur during the bloom-fruiting period. The BENOMYL + CAPTAN fungicide is very effective and should be first applied in the pre-bloom period just as the blossom buds are separating. A new fungicide, RONILAN (50W) is also effective against gray mold fruit rot, but it should be used in conjunction with CAPTAN for adequate foliage protection.

Proper spacing of plants, correct timing of fertilizer applications and good mulching are important in reducing fruit losses due to gray mold. Plants that are not densely spaced allow the blossoms and developing fruits to dry more rapidly than when plants are crowded. Fertilizer should be applied in the summer or fall rather than in the spring since spring applications encourage the development of a thick foliar canopy which inhibits rapid drying after rains or heavy dews. Straw mulch, properly placed, will help reduce the contact between ripening fruits and the soil. Frequent picking and removal of infected fruit also help reduce fruit losses.

Strawberry Pesticides, Days to Harvest, and Other Label Restrictions^[1]

| Compound | Interval ^[2] | Compound | Interval ^[2] |
|--------------------------|-------------------------|----------------|-------------------------|
| Benomyl | NTL | Guthion [4] | 5 |
| Captan | NTL | Malathion | 3 |
| Diazinon | 5 | Naled (Dibrom) | 1 |
| | | Ronilan | NTL |
| Dicofol (Kelthane) | 2 | Thiram | 4 |
| Endosulfan (Thiodan) [3] | 4 | Toxaphene | BF |

[1] All references are for use on strawberries only. Many compounds have different limitations on other crops. READ THE LABEL!

[2] Time in days between last application and harvest. NTL = no time limitation; PS = pre-plant soil application only; BF = do not apply after fruit starts to form.

[3] Do not repeat Endosulfan spray within 15 days or more than twice in 35-day period when fruit is present.

[4] Do not permit workers to re-enter field within 24 hrs. after application of GUTHION unless they wear protective clothing. For all other pesticides, no unprotected farm worker re-entry until the spray dries or the dust settles.

Missouri Poison Control Centers*

| City | Poison Control Center | Telephone | City | Poison Control Center | Telephone |
|----------------|---|-------------------------------|---------------------|---|--------------------------------------|
| Cape Girardeau | Southeast Missouri Hospital 701 Lacy 63701 | (314)651-5555 | Rolla | Phelps Co. Memorial Hospital 1000 W. 10th Street 65401 | (314)364-3100 Ext. 136 or 137 |
| Columbia | University of Missouri-Columbia Hospital and Clinics One Hospital Drive 65212 | (314)882-4141 | Springfield | Lester E. Cox Medical Center 1423 N. Jefferson St. 65802 | (417)831-9746 or 1-(800)-492-4824 |
| Hannibal | St. Elizabeth's Hospital 109 Virginia Street 64301 | (314)221-0414 Ext. 183/101 | St. John's Hospital | St. John's Hospital 1235 East Cherokee 65802 | (417)885-2115 Emer. Rm. |
| Joplin | St. John's Medical Center 2727 McClelland Blvd 64801 | (417)781-2727 Ext. 393 | St. Joseph | Methodist Hospital and Medical Center 7th to 9th on Faraon Street 64501 | (816)271-7580 or 232-8481 |
| Kansas City | Children's Mercy Hospital 24th & Gilham Road 64108 | (816)234-3000 | St. Louis | Cardinal Glennon Children's Memorial Hospital 1465 S. Grand Blvd. 63104 | (314)772-5200 |
| | | | | St. Louis Children's Memorial Hospital 500 S. Kingshighway 63110 | (314)454-6099 |
| Kirksville | Kirksville Osteopathic Hospital 800 W. Jefferson St. 63501 | (816)626-2266 | West Plains | West Plains Memorial Hospital 1103 Alaska Avenue 65775 | (417)256-9111 Ext. 258 or 259 |
| Poplar Bluff | Lucy Lee Hospital 330 N. 2nd Street 63901 | (314)785-7721 Ext. 166 | | | |
| Jefferson City | Charles E. Still Osteopathic Hospital 1125 So. Madison 65101 | (314)635-7141 Ext. 215 | | | |

*In the case of accidental poisoning involving a pesticide, follow the first aid directions printed on the label of the container and consult your physician immediately. Additional information concerning treatment and course of action can be obtained from your nearest poison control center.

This information is for educational purposes only. References to commercial products or trade names does not imply endorsement by the Cooperative Extension Service or bias against those not mentioned.

■ Issued in furtherance of Cooperative Extension Work Acts of May 8 and June 30, 1914 in cooperation with the United States Department of Agriculture. Leonard C. Douglas, Director, Cooperative Extension Service, University of Missouri and Lincoln University, Columbia, Missouri 65211. ■ An equal opportunity institution.

